L. Herber [Murray Bookchin] –

“The Problem of Chemicals In Food”

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Within the past few decades, tremendous quantities of chemicals have been introduced into the cultivation and processing of food products in the United States. The annual production of bread alone is estimated to involve the addition of about 10,000,000 pounds of chemical emulsifiers by thousands of bakers throughout the country. During the six-year period since the end of the war, at least 700 to 800 chemicals have been discovered for use in American food products. These substances cover nearly every aspect of production: from fertilizers and pesticides to substitutes for organic nutrients, preservatives, flavouring and colouring matter, and a legion of processing agents. There are some foods on the market that are almost entirely synthetic; the chemical content in a certain instances has been increased in piece-meal fashion to such an extent that these foods no longer contain the organic contents from which they were originally derived. This is the *ad absurdum* of chemicals in food; a natural product is converted by the continual addition of chemical materials into a synthetic or near-synthetic product. Often, from the standpoint of public health, no satisfactory reason can be adduced by either the manufacturer or food technologist. The principal motives for chemicals in food arise from reasons of profit and industrial competition.

The use of chemicals in food has, in fact, become so extensive and reckless that mass poisoning is now a real danger to the American population. Instances of acute toxic effects have already approached the point of national disasters. In one case, a marketed drug, ‘Elixir of Sulphanilamide’, killed over a hundred people before it was tracked down by governmental agencies. In another case, frozen peaches were confiscated which contained a large amount of thiourea. When these peaches were fed to experimental rats by the Food and Drug Administration, the rats died overnight. Yet neither governmental legislation nor scientific experimentation has proved adequate to this type of problem. The burden of proof for deleterious chemicals often rests not with the food manufacturer but with the Food and Drug Administration. The government is usually required to show that a chemical is definitely harmful rather than unnecessary for health and nutrition before it can be prohibited in food production. Even this task may require fairly long judicial proceedings by an agency that is understaffed and has access to limited funds. Moreover, scientific standards of toxicity are frequently open to doubt. Agene, for example, was used for decades in bleaching flour. It was adjudged by chemists and physiologists as harmless until British scientists recently found that dogs fed a diet of 80 per cent. white bread acquired ‘running fits’. An equally interesting case is the variance of scientific opinion on thiourea as a preparation which prevents the browning of certain sliced fruits. As late as 1943 this chemical was described as harmless to man. Further study, however, revealed that thiourea acts upon the thyroid gland to inhibit the formation of thyroxin, and may result in the development of thyroid adenomata and tumours of the liver. Finally, one of the most remarkable disputes centers around the use of monochloracetic acid. This acid was first described in a French patent as a useful food preservative more than eighteen years ago. After extensive pharmacologic tests, the use of monochloracetic acid was regarded as harmless ‘even in continued daily ingestion by infants’. Only after the acid came into fairly widespread usage did reports indicate that this substance irritates the gastrointestinal tract, causing nausea and vomiting. Yet Dr. Franklin C. Bing, an eminent authority on nutrition and food chemistry, testified that one of the food scientists who originally characterized monochloracetic acid as harmless to human beings, ‘still holds that monochloracetic acid is perfectly harmless and ought to be used’. Dr. Bing recounts the story of a food manufacturer 'who wanted to submit a product for consideration by our council [American Medical Association]. He had a little monochloracetic acid in his product as a preservative, and my duty as secretary of the council was to ask him what evidence he had as to its harmlessness, and he brought that in, and I told him I did not think that the council would accept it, and the council did not. And I remember vividly getting a couple of telephone calls from outstanding pharmacologists of this country saying that they thought we were wrong in not giving approval to that particular product'.

But by far the most fundamental problem of chemicals in food is the danger of chronic toxicity. Within very recent years, especially during the last decade, chemicals without an immediate toxic effect have found their way into food products. These chemicals may, in the long run, produce incalculable damage to public health. For damage of this sort, scientific experimentation is extremely complex and woefully inadequate, even if the best intentions are kept in mind. Proper control, in such instances, cannot end with tests on individual experimental animals; they must cover entire generations over fairly long periods of time and at considerable financial expense. More must be learned of animal physiology than is to-day even faintly suspected by the most eminent biologists in the United States. 'I have spoken to students many times about the newer knowledge of nutrition,' declared Dr. Bing in his testimony to the *House Select Committee to Investigate the Use of Chemicals in Food Products* (U.S. Congress), 'and I use the term somewhat glibly, but in the final analysis, I think I would have to admit that we know very little compared to what remains to be found out.

'Some of the things that we do know are that the body has mechanisms by which it can handle substances commonly or naturally found in food materials, and it may have some difficulty in handling substances which are not naturally found in foods, even though they differ only slightly in chemical configuration. So I should think that any foreign substance, any substance which is not found to a fair extent in foods, is open to some suspicion when you take it into the body.

In the meantime, the use of chemicals in food – tested, for the most part, only for acute toxicity, and this often with extreme superficiality – has increased by leaps and bounds. Dr. Bing observes: 'You can pick up almost any issue of the technical magazines which come to the attention of the chemists in the food industries, and find some little advertisement in them about new emulsifying agents, or something that is a plasticizer, or food improver, as they sometimes call them. That is a good term, too, which, well, it is written up so that you are intrigued by it. And it seems that just as human beings like to take a pill to relieve their illnesses or their lack of sense of well-being, so it seems to be typical of a man in the food industry when something comes along, some problem in technology, he likes to have chemical aids to solve it. That seems to be inherent in human nature, perhaps. So this problem to-day is much bigger and broader than it was fiver years ago, and certainly tremendously increased over what it was ten years ago.'

Chemical Fertilizers in Agriculture

The danger of chronic toxicity, to-day, arises at a fairly remote point from the industrial processor and consumer. It beings in agriculture and cattle-breeding, with a vast array of fertilizers, insecticides, pesticides, fruit colouring matter, hormones and growth stimuli. These chemicals (some of which are little understood by industrial chemists, still less by physiologists) are allowed to enter into great natural cycles whose ramifications touch upon the processes of life itself. Since natural processes are intricately tied together, an isolated view of the effect that any single chemical has upon life and nature is scarcely a basis for knowing how several of these chemicals will react together. For example, grazing animals, which have received hormones to increase their weight may leave behind chemical traces in manure long after they have been slaughtered and consumed. How the soil, as well as the public, is affected is little known. If, as often happens, the same area of land is treated with chemical fertilizers and sprayed with insecticides, these substances may very well combine to produce a totally unpredictable effect. The dangers inherent in this problem cannot be overestimated. Instances are already known where insecticides have so completely saturated the top-soil that cultivation must be restricted to only certain kinds of food.

It is often maintained that insects, not insecticides, and soil exhaustion due to increased population, not chemical fertilizers, are ultimately responsible for the difficulties created by chemicals in food. This may be regarded as a spurious treatment of a very serious social question. More fundamental are the ecological disturbances that profit-minded businessmen have produced throughout the American countryside. For decades, lumber companies and railroads were permitted a free-hand in destroying valuable forest lands and wild life. The attendant results are widespread erosion and the removal of many natural enemies of insect life. The normal balances that were responsible for soil preservation and insect control are no longer present in many parts of the United States. At the same time that irreplaceable top-soil is washed into the rivers of the country, it is accompanied by industrial wastes that probably abet the multiplication of insects and diseases detrimental to crops.

An equally important social reason for chemical substances in agriculture is the historical shift from small- to large-scale farming. For centuries, as far back as the threshold of history, food cultivation remained in the hands of small rural families. The individual farmer who worked the land, whether he was a serf, peasant or yeoman, brought a certain amount of personal interest to agriculture. The care of crops usually fell within the horizon of an individual, who felt himself more implicated in the quality of agricultural food than large-scale absentee land-owners. Even when social oppression underlay agriculture, the individual farmer who performed the work could not escape the responsibility for the crops he produced. Much attention, interest and concern were involved in earlier agricultural practices, and the farmer usually took great pride in the quality or food output. Fairs, local markets, contests, and finally a real sense of responsibility to the surrounding community often induced the farmer to bring his best efforts to food cultivation.

Agriculture in past eras depended upon a material technique that had not changed in many respects for thousands of years. Labour was arduous and famine remained a continual threat. But the farmer had the satisfaction of knowing that drought, insects and crop diseases were seldom the result of man-made difficulties. Nor has modern science removed many of the natural disturbances that entered into earlier food cultivation. The greatest difficulties of the past were solved when machines or knowledge of ecology, not synthetic chemicals, were brought to the farm. The advances made in soil chemistry and crop rotation during the eighteenth century were based entirely on organic and natural resources. Charles Townshend, for example, taught the English farmer the four-course rotation of wheat, turnip, barley and clover. Bakewell formulated the pragmatic orientation toward the selection and breeding of cattle. There is no better description of the agricultural advances of the eighteenth than the world ‘husbandry’. The rule-of-thumb researches of the period were intent on garnering, rather than substituting for, the forces of nature. The ‘conquest of nature’ meant a rational use of natural resources, not a disruption of the biological processes around man.

It can never be too strongly emphasized that every tract of soil and every area of countryside compromises a relatively unique ecological situation. Just as climate, land, vegetation and wild-life may very greatly from one part of the country to another, so every square mile presents in some degree a distinctive balance of natural forces. Food cultivation by man, which must be regarded as a form of botanical ‘domestication’ imposed on what was originally virgin and wild land, always threatens to upset this balance. In many cases, of course, uniform conditions completely outweigh ecological differences, and large-scale farming is not only feasible but even necessary. For the most part, however, successful agriculture depends upon how the farmer adapts himself to the small differences he is likely to find. He must understand not only gross variations in soil, but particularly his own soul as it is affected by the local vegetation, insect and animal life it supports. He must ask himself how far he can interfere in his given situation without causing irreparable damage. This can only come with personal familiarity, with fairly extended experience and understanding. The farmer must bring not only insight to the specific characteristics of his land, but also sympathy, interest, and a socially-responsible attitude.

With the shift to large-scale farming, the emphasis of agriculture changed from the quality to the quantity of food cultivation. This meant that the land was to be exploited like any other resource under capitalism – in a drastic and one-sided manner. The ‘success’ of large-scale, quantitative farming depended upon a uniformity of resources, and ‘average’ in the agricultural situation. Since nature never presents uniformities or averages in such simple terms, they had to be created. To a large degree this task devolved upon chemicals. Thus fertilizers were used to compensate for differences in soil; chemical hormones were employed to standardize the size of crops; and growth stimuli were discovered to replace the results of variations in climate. The most elementary lessons of man’s relationships to the soil and nature have since been abandoned for ‘synthesis’ – for artificiality not only in agriculture but also in nature. In short, ‘husbandry’ has been replaced by ‘chemistry’.

But just as capitalist farming has ‘created’ an ‘average’ agriculture, so it has created an ‘average’ farm worker. Wherever the farmer has been dispossessed by huge corporate growers, he has also been replaced by rural labourers who view the intimate problems of crop management with complete indifference. On large estates to-day, ‘farmers’ often include aviators who spray insecticides, tractor drivers and sales’ agents; not to mention harvesters who never sow and sowers who never harvest. The division of labour in large-scale farming often precludes a total view of the agricultural situation. Even the agricultural technician, who can provide an over-all view, must change his orientation to meet the needs of ‘average’ farming. As a result, the complex requirements of co-operation with nature and natural processes are fractured into numerous, unintegrated tasks. Management is often supplied – at least in motivation – from remote heights above, by business interests which include little appreciation for the problems of the soil. Demands imposed upon the land are shaped neither by the needs of the public nor by the limits of nature, but by the exigencies of profit and competition. All the gaps in the picture – from the variations of the land to the indifference of farm labourers – are filled by chemicals.

Fertilization by organic and inorganic (chemical) fertilizers plays a decisive part in altering various soils for ‘average’ farming. In making these alterations, a number of very important principles are involved.

Under natural conditions, the fertilization of land by organic materials is a process in the course of which complex substances are broken down into simpler plant nutrients. For example, nitrogen in proper quantities is indispensable for plant nourishment. Ordinarily, this element is provided through the well-known ‘nitrogen cycle’. When proteins decay, they are eventually reduced to carbon dioxide, water, ammonia, and free nitrogen. Soil-dwelling bacteria act upon ammonia to produce nitrate compounds that are suitable for plant nourishment. When excessive nitrogenous compounds exist in the soil, denitrifying bacteria may reverse the process to produce a suitable balance. Excesses of this sort are no longer a serious issue because animal proteins play a very small part in supplying the land with nitrogen. Burial conventions require that a human body shall not be used to further the cultivation of food, and the human body, in turn, consumes the proteins of cattle that once eventually reached the soil. But other means exist. Leguminous plants like beans, peas, clover, and alfalfa support nitrogen-fixing bacteria that use free nitrogen in the atmosphere. Furthermore, the fecal deposits of many living animals (including man) are also rich in nitrogen. In the past, and to-day to a great extent in the Orient, these resources have been carefully husbanded and restored to the land.

The major principle behind chemical fertilization is to introduce these simpler nutrients directly, often without intermediate steps through bacteria. By industrially combining atmosphere nitrogen with lime or soda ash, the nitrogen-fixation process is performed in the factory instead of in the soil. Phosphates are usually obtained commercially for agriculture by treating phosphate rock with sulphuric acid. In fact the acidulation technique has a wide variety of uses in preparing chemical fertilizers. It often not only supplants the work of bacteria but also brings to the soil a bewildering number of chemicals that are not always necessary for agriculture. The added chemicals often play no role whatever in soil fertility. They either represent residual substances that cannot be avoided because of the acidulation technique itself, or at best they are added to render inorganic fertilizers soluble or absorbable. Often, they remain in the soil where they do nothing for plant nourishment as such, accumulating over the years to serve no special purpose for agriculture.

Do these new accretions harm the soil? Do they play any role in human health? Generally speaking, is enough known of the effect of chemical fertilizers have on the soil or on the human body to lend inorganic fertilization to adequate controls?

Behind each of these questions are even more obscure problems.

During the hearings of the Select House Committee, for example, Mr. J. I. Rodale of the 'Soil and Health Foundation' suggested the complexities that are introduced by inorganic fertilizers as part of his objections to such fertilizers. 'In some cases they (chemical fertilizers) are caustic. They actually have a burning quality that will kill bacteria. In other cases they are too soluble. It is as if an individual were forced to eat when he were not hungry. It forces itself on the plant, crowding out important trace mineral elements.

'The most important reason why some chemical fertilizers are harmful,' continued Rodale, 'is because they contain more than one element. The one element that they need to feed the plant in order to make it soluble is tied in with some other element which gives it that solubility and which is there practically only for that purpose.

'An example is a very common fertilizer called superphosphate. What they are after is to feed the plant phosphate. But is it mixed with sulphuric acid to give it that solubility. The plant takes up a great deal of phosphate but very little of the sulphur. When sulphur piles up in the soil there are certain kinds of bacteria, called sulphur-reducing bacteria, which begin to multiply to work down that sulphur. As they work they have to feed. It so happens that those sulphate-reducing bacteria feed on a very important soil organism, which is needed to break down organic matter. Therefore when you have a lot of sulphur piling up in the soil there are bacteria multiplying which are killing off certain organisms which the farmer needs to break down organic matter.' This problem, which was first introduced because of the acidulation technique, reaches even further back. 'When you grow a crop of anything,' concludes Rodale, 'that root that remains in the soil must break down for the next crop. The roots are very valuable. The roots of the preceding crops give nourishment to the next. If the soil does not contain enough of this breakdown bacteria it will not be able to furnish the food in time for the next crop.'

Rodale's testimony may be regarded as a very unorthodox view in the United States. It was opposed at the hearings by a battery of 'experts' who vehemently argued for chemical fertilizers, 'judiciously' mixed with organic substances. Although the 'experts' freely acknowledged that organics keep the soil friable, easy to work and permeable to water, they pointed up transport difficulties and, in fact, the entire arrangement of modern society as objections to supplying the land with enough organic materials for agriculture. 'It is neither economically feasible nor physically possible to rely upon organic manures exclusively in our present-day agriculture,' observed Dr. Richard Bradfield of Cornell University, who particularly tried to place inorganic fertilizers in perspective from the specialist's standpoint. 'Organic gardeners make a great deal of what they call the "law of returns", by which they mean the return to the soil of all the elements which the crop removes from it. Such a system is feasible in a primitive, sparsely populated area in which practically the entire population is engaged in farming, and in which there is a high proportion of the population which can collect and transport city wastes to the farms which feed the cities. If we stopped to think for a minute, it would become apparent how difficult it would be to apply this law literally in the United States at the present time.'

In support of inorganic fertilizers, Bradfield insisted that such fertilizers supply elements in the same form that they are released by organic substances. In fact he found organic fertilizers of very limited value because 'the organic matter which is generally available for use on soils does not contain these elements in the proportions in which they are needed to give the best growth of crops on most soils.' Now we may reserve the social problems raised by the exclusive use of organics for later discussion. But Bradfield's unfavourable comparison of organic with inorganic fertilizers may be regarded as resting on entirely spurious premises.

Dr. A. F. Camp, Vice Director in charge of the University of Florida Citrus Experimental Station makes the observation that 'the difference between trees fertilized with organic fertilizers and those fertilized with chemical fertilizers lay primarily not in the field of nitrogen, phosphorous, potassium, and calcium but in the lack of the so-called minor or secondary elements such as magnesium, manganese, copper, zinc, and boron which were present as impurities in the organic materials but not present in appreciable amounts in the chemical materials. Thus, in the case of bonemeal which was credited with containing only nitrogen, phosphorous, and calcium, it was found that one of the most important elements it supplied was magnesium which is universally deficient in Florida citrus soils and for which citrus trees have a very high requirement. Superphosphate contained only traces of magnesium and when substituted for bonemeal resulted in trees that were acutely deficient in magnesium. All of these so-called minor elements which are actually as necessary to the development of citrus as the so-called major elements were found as sizable impurities in the natural organic materials because, just as in citrus, they were necessary to the growth or development of the organisms from which these organic materials were derived'.

Indeed, it hardly tells us much to criticize the efficacy or proportions of organic fertilizers that are 'generally available'. What is 'available' has a very restricted meaning in the lexicon of experts to-day. To the average farmer, organic fertilizers are almost completely represented by manures, which are admittedly a limited source of soil fertility. Even if we include the best composts in use to-day (and this being exceptionally generous) the term 'organic fertilizer', as it is currently employed, would ignore a wide range of potentially valuable substances which could be brought to the soil. Curiously enough, the 'experts' carry the greatest responsibility for this situation. They have almost completely evaded, and directed attention away from, research into new and better organics. Indeed, the current emphasis on inorganic fertilizers in agricultural laboratories and projects has reduced organic substances to an 'indispensable' but entirely ancillary position in food cultivation.

Bradfield went on to deny that 'valid evidence exists' to show that 'crops grown with chemical fertilizer are more attractive and nutritious to insects and plant pathogens'. This too will be discussed elsewhere. His denial, however, that evidence exists as to whether 'crops grown with chemical fertilizers are less nutritious to men than those grown with organic fertilizers' is extremely questionable. Slowly and in the face of extreme hostility from the 'experts', a number of soil scientists and practical farmers are producing evidence that inorganic fertilizers may seriously reduce the quality of crops. The discussion is still being cast in a strictly adaptive framework, as part of a general reconciliation to the use of chemicals. It is widely accepted that the contemporary social scene renders the use of inorganics necessary and few are willing to abandon chemical fertilizers as such. But, as Dr. K. C. Beeson pointed out, 'Fertilization with large quantities of nitrogen can also result in some lowering of certain nutritive constituents in the plant. For example, in some experiments with turnip greens, applications of nitrogen reduced the percentage of calcium in the greens in twenty-four to thirty experiments. Fertilization with the ammonium salts of nitrogen has resulted in a reduction of vitamin C in plants, but fertilization with the nitrates under the same conditions did not affect vitamin C. The reasons for the difference are unknown.'

Perhaps the most strongly emphasized point made by all the 'experts' in favour of inorganic fertilizers is the conclusion that chemicals increase crop yield. 'The most important reason for the use of fertilizers,' said Bradfield, 'is that they increase the yield of practically all crops on all but our most fertile soils. This point is so generally appreciated that detailed elaboration is unnecessary'. Very well, then – let us elaborate!

By leaning on poorly-evaluated experimental facts, the 'expert' generally knows that the addition of certain chemicals to the soil can increase the size of crops. Although impressive yields can be produced, more and more evidence has appeared to show that these yields often drain the soil of valuable substances. Dr. William A. Albrecht of the University of Missouri astutely observed at the Hearings that 'a fertilizer balancing the supply of nutrients in the soil is merely a help to take all the other things out faster. So if you fertilize a soil with nitrogen, which is deficient, and grow a bigger crop, you merely have taken all the other things out faster and by virtue of that observation people will say, "Oh, yes, fertilizers ruin your soil". Well, they have just helped you wear it out faster. That is all.'

But *is* that all? 'We have built up the lime, the phosphorous, the potash,' continues Albrecht, later in his testimony. 'Now we come along and shove under the nitrogen and that is very demonstrative for the first year or second year until we pull the other things down. We had the same thing with limestone. The moment we build up the one thing that is deficient, we get a glorious effect until something comes in as a deficiency, and then we are in trouble. . . . Lime is a necessity but like alone is not enough. Many years ago the farmer, who did not know any chemistry, gave us a very interesting jingle which is very true: "Lime and lime without manure make father richer but son poorer."

'A very find old truth, very fine, because when you lime, the calcium next to the hydrogen serves to push the other things out. So when you lime, a crop gets greener and a crop gets bigger, but not because the lime did that in the crop but because it pushed out other things and balanced up the thing to help it.'

Before chemicals can replace organic substances without leading to disaster, more must be known of the factors which enter into soil composition, of the soil itself and finally of plant and animal nutrition; in short, of a stupendous natural process concerning which agronomists know surprisingly little. The soil, as Dr. Beeson has put it, is 'a highly complex dynamic system of minerals, inorganic chemical compounds, organic compounds, living organisms, air and water'. Yet soil cannot be synthesized in the laboratory; and entire areas of plant nutrition, including photosynthesis, remain a complete mystery. In fact, as Beeson tells us, 'There is no known laboratory method or group of methods by which all the nutritive constituents in food can be measured and evaluated in terms of the nutrition of man or animals. Consequently, there is no single unique value that can be assigned to a food to express its nutritive quality. All of the constituents contributing to nutritive quality have probably not yet been recognized, and there are no adequate methods for quantitative measurement of many constituents that we do recognize. Therefore, no measurement of the over-all nutritive quality of a food has ever been made'.

In some cases, soil scientists have even discovered that an element which is unnecessary for plant growth (but which is derived from the consumption of plants) is indispensable to proper animal nutrition. Soil deficiencies of cobalt, for example, have resulted in nutritional disturbances in cattle and sheep. Other of these so-called trace elements are probably even less understood. The point is that whereas the 'experts' tend to break up, simplify and crudely manipulate the agricultural situation, supporters of organic farming usually predicate themselves on the complexity and far-reaching character of food cultivation. There is more than a difference in technique. It is a basic antagonism in outlooks toward natural phenomena. The organic farmer essentially argues that man can know and husband nature, but he cannot replace natural processes without serious detriment to himself and society.

Insects, Insecticides and the 'Human Bug'

If the rejection of chemical fertilizers rests on the complexity and obscurity of the agricultural situation, there are very direct reasons for regarding other chemicals in agriculture as detrimental to human health. Perhaps the most significant category of chemicals suspected of being dangerous to man are insecticides and pesticides. The problem that these substances presents is very simple: All are poisonous to one or several forms of lower life. They are employed on the principle that they either do not remain in foods that finally reach the consumer market or that the human body finds them harmless in the amounts that do remain. Both 'principles' are now open to grave doubts by physiologists and biochemists.

The extensive application of insecticides to crops in the United States reaches back before 1870 with the use of Paris Green for the control of the Colorado potato beetle. Afterwards, a number of extremely toxic chemicals came into use. Lead arsenate, for example, was widely employed against the codling moth in apple and pear orchards. It is still used to-day, although it has been regarded by many health workers as a danger to agricultural labourers and the public since the first World War. The use of insecticides has now grown to incredible dimensions. With the passage of the Federal Insecticide, Fungicide and Rodenticide Act of 1947, about 16,000 brands of insecticide preparations have been registered with the government. These brands range from poisons absolutely deadly to man to very questionable 'hormone' herbicides like 2, 4-D dichloro phenoxy acetic acid. 'One of the disturbing things about the recent advance in insecticides, in the discovery of new insecticides,' said Dr. Dunbar to the Select Committee, 'has been that a great many very potent and valuable insecticides have been developed on which very little is known, either about their chronic or acute toxicity or about their fate after they are applied to food.

'In many cases we do not know whether the insecticide after application is absorbed into the body of the food, whether it is destroyed on weathering, were even insecticides put out for which no chemical method of identification or analysis is known.'

Many insecticides and pesticides are known in some way to affect higher animal organisms, including man. Hydrogen cyanide, a fumigant commonly used on grains and cereal foods, is described by a Food and Drug official as 'moderately to extremely poisonous; however, under normal conditions of use the fumigant volatilizes so that no significant [! – L.H.] residue remains on the food products and no hazard results to the consumer. An exception [! – L.H.] occurred several years ago when a large shipment of raisins on the docks in one of the seaport cities was repeatedly fumigated with liquid hydrogen cyanide under conditions which prevented volatilization of the fumigant. These raisins were distributed and resulted in numerous illnesses to consumers'. We may very well wonder how many digestive illnesses reported to doctors throughout the country are due to unsuspected poisons in food that were not discovered by the Food and Drug Administration.

It is maintained by may 'experts', that when insecticides are produced from simple compounds they can be washed away and kept from directly affecting the public. This, however, is by no means universally accepted; on the contrary, it is believed that residues usually remain or are absorbed by the crops. According to Dr. Francis E. Ray, Director of the Cancer Research Laboratory (University of Florida), arsenic 'in the form of copper arsenate or lead arsenate is commonly used as an agricultural insecticide and fungicide. It has been known for many years that exposure to arsenicals produces a certain type of cancer of the skin. More recent evidence is that inhalation of arsenic dust – and sprays – may cause cancer of the lung. It is possible that other types of internal cancer may be caused by the long-continued ingestion of so-called non-toxic doses of arsenicals. It is suspected that the arsenicals used in growing tobacco contribute to the high incidence of lung cancer among heavy smokers. Arsenical sprays on tobacco and food should be prohibited'.

Another 'simple' chemical (indeed, an element) that has come into widespread use against insects is selenium. Experimental study by the Food and Drug Administration indicates that selenium and its compounds 'are highly toxic and are capable of producing insidious poisoning. When as little as three parts of selenium (in the form of selenized corn) was added to each million parts of the diet of rats, it produced liver disease (cirrhosis) in the majority of the animals within a year. Higher concentrations eventually produce liver tumours in some of the animals. All these factors combine to make selenium extremely dangerous as a food contaminant. Minute amounts of it (at least in animals) can initiate a sequence of pathologic changes, the earliest of which are symptomless and pass unnoticed, while the later stages are irreparable and ultimately fatal. These facts combined with our conviction that the use of selenium-containing sprays could be avoided, have been the basis of our reluctance to set any tolerance whatever for selenium residues on fruit'.

In 1942, the Food and Drug Administration initiated a series of experiments and studies to ascertain the extent to which ordinary packing house washing removed selenium from oranges, and the degree to which this substance accumulated in the soil after repeated usage. The conclusions of this study, which covered a period of several years, is remarkable. 'Washing as ordinarily practiced removed little or none of the selenium,' dryly observes a memorandum of the agency to the Select Committee. 'Soil in groves with a history of repeated spraying showed a selenium level ten or more times that of unsprayed groves, and the flesh of oranges grown on the soil showed the same selenium level as above, even though no spray had been applied to this crop.' As of the hearings, however, the Food and Drug Administration has not been able to remove this substance from the market. Even State agencies, with whom the Administration discussed the insecticide on 17th January, 1950, were of the opinion that a selenium product was 'necessary under certain conditions to control mites'.

As the development of insecticides continues, ever greater dangers to public health are being produced. Perhaps one of the gravest hazards arises from recent insecticides developed around hydrocarbons – the organic insecticides like the chlorinated hydrocarbons (chlorinated camphene, etc.), the organic phosphates (parathion, etc.), and so on. Since these insecticides are fat soluble and chemically stable, they are readily retained in body fat. The human body can acquire parathion, DDT and similar hydrocarbons from any number of vegetables, fruits, milk, and even the flesh of sprayed fowl and cattle. No limit has been agreed upon by the 'experts' on how much of these substances can accumulate in the fat of the organism. Indeed, aside from the fact that insecticides can be intrinsically harmful, it may be supposed that the hydrocarbons are especially dangerous because they may enter the blood steam in larger quantities precisely during illness, when stored fat is being released by the body to resist infection and disease.

According to an article by W. A. Brittin, head of the food laboratory of the Beech-Nut Packing Co.: 'These organic insecticides reached the market for general use before adequate information was available on the acute or chronic toxicity of the chemicals involved… with the exception of one or two insecticides, methods of analysis were lacking which were specific for these various organic spray residues.' When chlordane was introduced for use in agriculture, for example, one manufacturer described the insecticide as being half as toxic as DDT. Afterwards, the belief was expressed in sales literature that chlordane 'is among the safest of all available organic insecticides'. According to Dr. Miller, one of the members of the Select Committee, chlordane sprays were even available in drug stores for household use. If we are to accept the opinion of Dr. Lehman of the Food and Drug Administration, however, the truth appears to be that 'chlordane is one of the most toxic insecticides we have to deal with… First of all, it penetrates the skin very readily. Therefore, anyone handling it could be poisoned. Or of it is used as a household spray, the potential hazard to living in these houses is quite great because of the ability of chlordane to penetrate the skin and because of the volatility of the insecticide and the possibility of poisoning by inhalation. More to the point is that it is very toxic to the liver and kidneys of an individual. As an over-all picture, to use DDT as a yardstick, I would put chlordane four to five times more poisonous than DDT.' Yet at the time that the Food and Drug Administration conferred with a manufacturer of this substance, (23rd September, 1947) it was reported that 700,000 pounds of chlordane had been sold, and another company had sold approximately 300,000 pounds. When Lehman was asked if chlordane was employed extensively as an insecticide he replied that 'based on poundage it must have been quite widely used'. Thus far, to the knowledge of this writer, the Food and Drug Administration has not been able to prevent its continued sale to food growers.

Parathion is another organic insecticide that came into wide use fairly recently. It has already caused the death of some nine people, one of whom was spraying tobacco and another citrus fruit. Although Dr. Lehman believes that this insecticide is 'quite safe for use' and that no 'evidence' exists to show it is harmful to consumers eating foods sprayed with parathion, he was obliged to make the following judgement: 'Parathion is a liquid. It penetrates the skin. It is very poisonous.

Very small amounts will produce fatal poisoning.' This order of opinion – that a substance is 'very poisonous' but no 'evidence' exists to show that it will harm consumers when used on crops – is often the most favourable response that can be elicited from governmental agencies like the Food and Drug Administration. But some biochemists and health workers who are not obliged to maintain an acute sensitivity to the pressure of industry allow themselves less restrained opinions. Dr. Franklin C. Bing, in conjunction with a committee on food and nutrition, has made the more sweeping observation that, 'Contrary to previous beliefs, it now seem likely that a substance which is poisonous to one form of life is very apt to be found to some degree toxic for other animals, including man'.

This observation appears to have received its most striking confirmation with the use of DDT, an insecticide which for years was heralded as completely harmless to man and extremely effective against insects. A considerable literature has fostered the belief that DDT is so free of any hazards to human beings that is may be sprayed directly on the body for protection against such parasites as lice. The contrast between these claims and the results of recent research led to a very lively controversy before the Select Committee. Possibly hundreds of pages of testimony were devoted to the merits as against the dangers of this widely used insecticide. It is interesting to note that few experts were prepared to maintain that DDT is completely harmless; the dispute actually centred for the most part, on whether DDT, once regarded as without any hazard whatever, is to-day responsible for an epidemic of nervous and physical disorders!

This controversy reached its most acute point in the testimony of Dr. Morton S. Biskind, who has devoted himself to extensive research into the pathological symptoms of DDT poisoning. According to Dr. Biskind: 'The introduction for uncontrolled general use by the public of the insecticide DDT, or chlorophenothane, and the series of even more deadly substances that followed has no previous counterpart in history. Beyond question, no other substance known to man was ever before developed so rapidly and spread indiscriminately over so large a portion of the earth in so short a time. This is the more surprising as, at the time DDT was released for public use, a large amount of data was already available in the medical literature showing that this agent was extremely toxic for many different species of animals, that it was cumulatively stored in the body fat and that it appeared in the milk. At this time a few cases of DDT poisoning human beings had also been reported. These observations were almost completely ignored or misinterpreted… DDT is as lethal in repeated small doses as in larger single doses. In low-grade chronic poisoning in animals, growth is impaired, and the implication of this observation for the growth of children should be given serious consideration. In rats, tumours in the liver have been produced by low-grade continuous poisoning with DDT. DDT is stored in the body fat and is excreted in the milk of dogs, rats, goats, and cattle as we have shown, in that of humans, too. Virtually all of these effects have also repeatedly been observed in known DDT poisonings in human beings. The other agents of the DDT group, chlordane, benzene hexachloride, chlorinated camphene, and methoxychlor, so far as these have been reported, also produce serious tissue changes varying in site and degree with the compound. Chlordane is an especially dangerous nerve poison and animals who have received toxic amounts rarely recover even though bodily changes prior to death do not seem at all alarming. Fortunately in my own limited experience with chlordane poisoning in man, I can report that with stringent avoidance of further exposure and intensive nutritional therapy to help repair the tissue damage, recovery does occur, though this may not be complete. Benzene hexachloride changes the chromosomes of plants and probably, too, those of animals. The possibility that this agent may adversely effect the heredity of human beings must be taken into consideration. Already in one report from Europe, seedlings treated with benzene hexachloride were so altered in their heredity that it was suggested that nondegenerated stocks be used for seed subsequently… We are dealing with double-edged swords, for the very substances now promoted to increase the size of our crops in the long run turn out to be detrimental to agriculture itself. All these substances and the fantastically toxic parathion, too, inhibit the growth of certain plants, and compounds of the DDT group also persistently poison the soil, so far as present evidence goes, for five or six years and possibly indefinitely.'

In the course of his testimony, Dr. Biskind carefully elaborated the symptomology of DDT poisoning. A comparison of these symptoms with alleged 'virus' epidemics in many American communities has suggested to him that many of these epidemics may actually result from mass DDT poisoning. Biskind's experience with individual patients suggests that this belief is by no means as reckless as it first appears. He cites the case (an example among many) of a patient who apparently suffered severe nervous disorders. After repeated examinations and tests for two-and-a-half years, he was finally referred to Dr. Biskind for treatment. 'When I saw this patient,' observes Dr. Biskind, 'he had an enlarged tender liver, sings of nutritional impairment, reduced ability to feel vibration in his legs and a reduction in his pulse pressure. Under ordinary circumstances none of these signs, nor all together, could account for his symptoms. When he was advised to give up his job as seek less toxic employment, to remove all traces of DDT and chlordane from his environment, was given nutritional therapy to alleviate the liver damage and put on a diet low in insecticide residues, he showed prompt improvement within a week. Four months later he was almost free of symptoms. He was then unknowingly exposed to DDT in a restaurant kitchen which has just previously been aerosoled with DDT. Within half-an-hour the entire syndrome returned and required more than a week to subside.' It may be noted that Dr. Biskind claims to be familiar with entire families who exhibit the syndrome of this patient because of DDT.

Experimental evidence favourable to DDT ordinarily rests on situations where a group of people are voluntarily exposed to a few repeatedly large doses of the insecticide. Since no acute pathological findings are reported by these 'experiments', it is assumed that DDT is harmless to human beings except in cases of individual sensitivity. Thus the tendency is to regard all admitted cases of DDT poisoning as exceptional, where an individual rather than a public reaction is at stake. This approach is slowly being reversed by a number of researchers. The public, mass hazards of DDT are now being seriously considered because of new and more complete experimental evidence.

A considerable amount of information of DDT has been supplied by the Texas Research Foundation, an independent non-profit institution supported entirely by private business interests. According to Mr. John M. Dendy, head of the analytical division of the foundation:

'1. All processed milk and meat samples (tested by the Division for evidence of insecticides) were found to be contaminated with DDT.

'2. The degree of contamination ranged from 3.10 parts per million of DDT in lean meat to 68.55 parts per million in fat meat. In milk the contamination ranged from less than 0.5 parts of DDT per million in 13.83 parts per million.

'3. Both corn and sunflowers sprayed with insecticides were found to absorb the chlorinated hydrocarbons in unchanged form.

'4. The rate of absorption was found to be cumulative, the degree of contamination increasing with each spraying. The extent of absorption in corn ranged from zero parts per million where there was no spraying to 8.11 parts per million after two sprayings with insecticide. Contamination of the sunflowers ranged from zero for no spraying to 3.72 parts of insecticide per million after one spraying and 7.40 parts per million after two sprayings.'

Mr. Dendy concludes as follows: '… one of these insecticides [a reference to several organic insecticides tested by the Division, including DDT], when sprayed on a crop such as corn is absorbed by the corn. The dairy cow or beef cow which feeds on the corn in turn absorbs a portion of the chemical in its fat, and the insecticide is passed on to the human being who consumes milk or beef from the animal. In experiments in the laboratories of A. J. Lehman, M. I. Smith, and H. J. Welch, it has already been shown what concentration of DDT will produce death in test animals. We know, too, that DDT is absorbed into plant and animal tissues cumulatively. Therefore, we can only conclude that the continued indiscriminate use of DDT and other chlorine hydrocarbons holds an ever-increasing hazard to the public health.' Later in his testimony, Mr. Dendy points out that, ‘Milk containing small concentrations of DDT has been found by most of the investigators in the field. Even though the intake is small, the fatty accumulation in the tissues as the result is magnified as high as thirty-four times the original intake. In other words, with a diet of ten parts per million you could expect, in some instances, 340 parts per million in the fat’. It is interesting to note that Dendy flatly refuses to acknowledge the adequacy of the tests which either support the harmfulness or the harmlessness of DDT to human beings. ‘As I see it, in this particular field,’ he observes, ‘we exposed almost everything to the indoctrination of DDT. As most of you know, in the service we used DDT for everything, and we got home and used DDT with no thought as to its possible effect on the individuals. Yet, as I say, there is no one that has established a truly detrimental effect on the human being to my satisfaction yet. There has been no elaborate human test made yet. Someone has to authorize, delegate and carry on such experiment, to ascertain whether or not all this wealth of information is going in the wrong direction. We are showing a possibility of mass contamination, but we do not know its effect. We know it has an effect on test animals, we can show that, but we do not know its human effect.’ Perhaps we have misunderstood Mr. Dendy, but this is the same acme of the positivist method: animals are known to respond adversely, but since no test has been made on man, Dendy is not satisfied that DDT is detrimental to human beings! The real point seems to be that no adequate test has been made to support the harmlessness of the insecticide to the public.

In the meantime, DDT is ubiquitous. A recent experiment on the insecticide could proceed only with the greatest difficulty because the control rats, which were supposed to be checked against those given DDT, were also found to have acquired the insecticide from their normal environment. Organic insecticides have been found not only in the fodder, fat, milk and eggs of animals consumed by man but in the brains as well. The dangers of DDT to public health have been echoed in the reports of Dr. Lehman, who acknowledges under questioning by the Select Committee ‘that the potential hazard of DDT has been underestimated…’ But few remarks sum up the meaning of DDT to the public health more vividly than the following quotation from a British food journal (cited by Dr. Biskind):

‘Atomic bombs and DDT will be regarded by many as the two most notable scientific developments of the war. They have now been brought together in a more direct and scientific sense by recent British research carried out by the Pest Infestation Laboratory. Radioactive isotopes produced as the Harwell Atomic Pile have been used to study the biological movement of DDT residues…’ After reporting that an insecticide almost identical to DDT has been found in the ‘gizzard, the liver and the kidney, the tissues of the heart and brain, and the sciatic nerve fibre’ of test hens, the quotation concludes: ‘These new results give strong confirmation for the view that DDT is a hazardous contaminant of animal and human foodstuffs. Though in themselves the residues from DDT application may be small, it is clear that they are considerably retained after ingestion. Toxic effects of a harmful if not lethal nature could arise from the cumulative absorption of DDT residues.’

Actually, the coupling of atomic bombs with organic insecticides as the most noted scientific developments of the war is not a helpful amalgam. Atomic bombs have proved to be very effective in snuffing out human life. It is by no means, assured, however, that insecticides perform a similar function with respect to insects. If we are to accept a number of very remarkable facts brought out before the Select Committee, it would appear that not only do insecticides often fail to provide a long range solution against insects, but they may even result in the widespread appearance of new pests. It is ironic but apparently true that the use of many insecticides leads to the development of resistant varieties of insects, while producing new pests by destroying their natural enemies. ‘The New York *Times* last April (1950),’ claims Dr. Biskind, ‘carried items indicating that because the wheat crop was threatened by green bugs and red spiders, more than 200,000 acres has been sprayed with parathion by airplane. What was omitted from the news dispatch was that the crop was threatened only because prior use of DDT had killed off the normal predators of these two resistant insects, permitting them to flourish uncontrolled. Apparently the remedy for too much poison is still more.’ A similar situation has been reported by leading entomologists like Dr. Charles E. Palm of

Cornell University. ‘As far as the same number of insects,’ declares Dr. Palm, ‘we probably has most of them before, but we have cases in our own experience where we have some minor pests that have become of major importance – I say possibly – through the use of insecticides, I think of the red-banded leaf roller on fruit. It was always a minor problem, and as long as we used lead arsenate for control of the codling moth, it was no particular problem to the commercial fruit grower. But there is the possibility that DDT has reduced the parasites of the red-banded leaf roller as a problem that we have to contend with because we still have to control the codling moth with DDT. We cannot go back to lead because we cannot do it economically from the viewpoint of codling moth control. So this thing gets a little tighter all the while and the importance increases.’

This type of problem has become so acute in recent years that there is a tendency for ‘experts’ to juggle the effectiveness of an insecticide against the natural predators of other pests which may also be destroyed. Dr. V. B. Wigglesworth, of the Agricultural Research Council in Cambridge, England, was obliged to suggest that ‘an insecticide which kills 50 per cent. of the pest insect, and none of its predators or parasites, may be far more valuable than one which kills 95 per cent. of the pests, but at the same time eliminates its natural enemies. Perhaps this is where the future of chemical insecticides lies, not as a substitute for, but as a complement, to the more subtle and more remunerative methods of biology’. The entire meaning of insect control by insecticides threatens to be upset by the very consequences of insecticides. In an article, appropriately called ‘The Philosophy of Orchard Control’, A. D. Pickett of the Dominion Entomological Laboratory in Nova Scotia writes ‘that when a chemical is used for some specific purpose, such as the control of a fungus disease, it may increase the survival potential of one or more pests which were unimportant before the spray was applied. An example of this is the increase in population of oyster shell scale and European red mite following applications of elemental sulphur’.

The British have tried to show some moderation in the use of insecticides; the Americans, however, work on the principle that the bug must be bludgeoned… or else! The difference in national attitudes reflects itself in the fact that while British ‘experts’ are thinking of reducing insecticides and, in some measure, getting nature to work with them, the American ‘experts’ continually increase the dose of an insecticide as the pest grows more and more resistant, until complete resistance has been achieved. At the same time, the increased dosage adds to the contamination of food and tends to complete the destruction of natural enemies, including not only other insects which are helpful to man but also wild life and birds.

Insects, to-day, destroy more than $4,000,000,000 worth of crops a year. The problem of controlling them, as Dr. Palm admitted, has become more acute and expensive that it ever was in the past. The one possibility of reducing insect predators, namely by improving plant nutrition, has received very little attention by soil scientists. Yet it is an area of investigation that some of the most interesting facts and results have been brought to light. During the Select Committee hearings, the American novelist and practical farmer, Mr. Louis Bromfield, frankly stated his belief that the ‘increasing attack by insects and diseases upon our agriculture and horticulture has arisen largely through poor and greedy agricultural methods, through the steady deterioration of soils and the steady loss of organic material with which nitrogen is closely affiliated, and the increasing unavailability of the natural elements though the loss and destruction of soil structures and content. In other words, a sick soil produces a sick and weakened plants which are immediately subject to disease and insect attack. In properly managed soils the necessity for using poisonous preparations injurious to animals and people is greatly diminished and in many cases disappears altogether. The general deterioration of most soils in the United States since the first plough entered them is closely related to the increasing attack of disease and insects and the consequent short-cut use of poisonous dusts and sprays later consumed by humans.’ Falling back on his extensive experience in farming, Bromfield went on to say: ‘I myself farmed and gardened in France, on land that has been in use for 1,200 years, for seventeen years without every using a dust or spray. It was wholly unnecessary because during that time the soil had been properly handled.’

According to Mr. Bromfield, the University of Missouri ‘has found that sufficient amounts of the element nitrogen will control the attack of chinch bugs on corn. They found that corn not suffering from nitrogen starvation was simply not attacked by the pests'. Similar experiences have been obtained 'in related to the attack of the green bug on wheat' in Kansas. 'The green bug,' observed Mr. Bromfield, 'does not start on one side of the of the field and work his way across. They always go to work on the yellowish spot in the field and they work out in a circle. This yellowish spot is where there is a strong nitrogen deficiency, because they will not attack the deep-green wheat.' Bromfield's remarks are a matter of record in the scientific journals and have even received confirmation from workers in the field who still regard the use of insecticides as indispensable to agriculture.